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(54) Mechanical connection for polarization-maintaining optical fiber and methods of making.

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Description

Technical Field

This invention relates to a mechanical connection for polarization-maintaining optical fiber and methods of making.

Background of the Invention

Polarization-maintaining (PM) fibers sustain a substantially stable state of polarization in single-mode transmission and are important in applications such as coherent communications, fiber devices and sensors and photonic switching. One type of polarization-maintaining fiber is a stress-induced bireffringent optical fiber disclosed in U.S. patent 4,274,854. See also U.S. patents 4,515,436 and 4,529,426.

Suitable connection technology for fibers is essential to the successful use of polarization-maintaining fiber. The suitable connection technology must preserve a low loss and minimize polarization extinction ratio degradation for the optical fiber. Polarization extinction ratio is defined as the logarithm of the ratio of power leakage, which is orthogonal to the excited polarization axis, to that of the total launched power. Splice loss depends only on the transverse and longitudinal offset of the fiber cores whereas the extinction ratio depends only on the angular offset between the polarization axes of the two fibers. Accordingly, in order to obtain acceptable properties through a connection, it is important to align not only the fiber cores, but also the polarization axes.

Alignment of the polarization axes of the two fibers to be interconnected, which is very important, must be within a tolerance of about 1°; otherwise the extinction ratio is degraded substantially. The task of aligning the polarization axes would be simplified if the polarization axes coincided with the geometric axes of the optical fiber cross section. Generally, however, polarization-maintaining fibers do not have geometric axes that coincide with the polarization axes. For a circular cross-section optical fiber, for example, expensive apparatus must be used for a determination of the direction of the polarization axes. However, a polarization-maintaining optical fiber having a generally rectangular transverse cross sectional configuration of an outer cladding layer, for example, is beneficial and brings the geometric axes and the polarization axes into coincidence. It facilitates the determination of the direction of the polarization axes.

In the prior art, most polarization-maintaining fiber splicing techniques have used fusion or adhesive bonding. Fusion splicing requires expensive micropositioners to align the cores in addition to rotational stages to search for the polarization axes of the fundamental mode. Furthermore, problems occur in polarization-maintaining fiber splicing when the residual stress profile of a fiber is deformed due to dopant diffusion during fusion and core deformation in stress-induced fibers. Adhesive bonding has shown some instabilities due to volume shrinkage during a curing process.

Another consideration derives from the fact that in many applications, only a relatively short length of polarization-maintaining fiber is required. Should there be misalignment of the optical fiber cores and birefringent axes, undesired effects such as excessive overall attenuation or a reduction in the signal-to-noise ratio due to polarization noise, modal noise and reflection loss may occur. In some instances, reflections can contribute to laser instability through optical feedback.

What is sought after is a passive mechanical connection system for polarization-maintaining optical fibers. The desired connection system should combine and simplify fiber end preparation, fiber core and polarization axes alignment. End preparation which is accomplished by mounting the fibers in a supporting structure and polishing provides connection components that are easier to align than bare fibers. Also needed is alignment hardware which does not require subsequent operations for alignment retention. A mechanical connection system for polarization-maintaining fibers would eliminate the problem of stress profile deformation during fusion and volume shrinkage instabilities due to adhesive bonding. Furthermore, a passive connection system for polarization-maintaining fibers is desired. The sought-after passive system should be one which facilitates accurate alignment of polarization-maintaining optical fiber cores and axes without the need for the elaborate micropositioners that have been used in the past. As far as is known, the prior art does not include such a mechanical connection arrangement for polarization-maintaining fibers.

WO 87/05119 describes an array connector for polarisation-maintaining optical fibers as described in the preamble of claim 1.

According to the present invention, there is provided a connection as defined in claim 1, or a fiber termination as defined in claim 4.

The foregoing problems of the prior art have been overcome with the mechanical connection system of this invention. It should be noted that for purposes of this invention, the term mechanical connection system or connection is intended to include connectors or splices as those terms are used in the art. The system includes a polarization-axis reference which is external to an optical fiber to facilitate accurate axial alignment of two polarization-maintaining optical fibers. without the need for expensive and elaborate micropositioners. In a preferred embodiment, the system includes two ferrule shaving passageways each of which is defined by at least one substantially straight line. Polarization-maintaining optical fibers

each having a hybrid outer cladding configuration, which is defined by at least one substantially straight line that is parallel to one of the polarization axes of the optical fiber, are inserted into the passageways. Each ferrule has a marking associated therewith in a predetermined orientation with respect to the substantially straight line of the hybrid cross section of the outer cladding layer of the optical fiber end portion in the ferrule and hence with respect to one of the polarization axes of the fiber. The connection system facilitates alignment of the markings and hence passive alignment of the polarization axes of the fibers. Extinction ratio measurements may be performed on the mechanical connection to carry out active alignment of the polarization-maintaining fibers to enhance the alignment. However, such active alignment is not necessary to provide an acceptable mechanical connection for the two polarization-maintaining fibers.

It should be understood that the polarization-maintaining optical fiber includes several cladding layers, an outer one of which may be the starting substrate tube. It is the outer cladding layer which has the hybrid configuration in a cross-section transverse to a longitudinal axis of the optical fiber.

In the preferred embodiment, each connector of the connection system includes a ferrule and a plastic housing in which is disposed an end portion of the ferrule. An end face of a free end portion of a first ferrule is destined to become disposed adjacent to the end face of a free end portion of a second ferrule. Each ferrule has a passageway extending therethrough, at least a portion of which that opens to an end face of the free end portion is substantially rectangular in a cross section transverse to a longitudinal axis of the ferrule. Prior to the separation of two ferrules from a length of stock, each plastic housing is fitted with a tab such that the tab is perpendicular to the long sides of the rectangular shape of the passageway. Optical fiber to be received in the passageway of each ferrule includes an outer cladding layer which has a hybrid configuration comprising two ends and two parallel sides such that one of the orthogonal polarization-axes of the optical fiber is parallel to the parallel sides of the outer cladding. As a result, when an end portion of a polarization-maintaining fiber is positioned in the rectangular passageway, the associated tab is normal to the parallel sides or flats of the fiber which are parallel to one of the polarization axes of the fiber. For a connection, two of the ferrules are supported with their tabs aligned thereby causing the polarization axes of the optical fibers to be aligned.

In the preferred embodiment, the first and second ferrules are contiguous segments of a length of cylindrical stock. The first and second ferrules after having been separated from the stock are arranged so that their adjacent end faces in a connection system were contiguous prior to separation from the stock. Further, the first and second ferrules after separation are caused to have the same rotational orientation with respect to a longitudinal axis of the connection system as the ferrules had prior to their separation from the stock.

Brief Description of the Drawing

FIG. 1 is an end view of an end portion of a polarization-maintaining optical fiber disposed in a passageway of a ferrule with an identification tab disposed in a predetermined orientation with respect to polarization axes of the optical fiber;

FIG. 2 is an end view of an optical fiber enclosed in a buffer layer, a strength system and a jacket;

FIG. 3 is a side elevational view of an optical fiber termination assembly which includes a ferrule with an optical fiber disposed therein and a housing in which the ferrule is mounted;

FIG. 4 is an elevational view partially in section of the termination assembly of FIG. 3;

FIG. 5 is an end view of a ferrule which shows a rectangular passageway disposed eccentrically with respect to a longitudinal axis of the ferrule;

FIG. 6 is a side elevational view of two terminated optical fibers after their interconnection;

FIG. 7 is an end view of the ferrule of FIG. 5 with an optical fiber positioned therein;

FIG. 8 is an end-view of the ferrule of FIG. 7 after the optical fiber has been repositioned within the passageway;

FIG. 9 depicts schematically a length of tubular stock comprising several ferrule segments;

FIG. 10 depicts a two ferrule segment portion of tubular stock prior to separation and having rotational identification means;

FIG. 11 is a side elevational view partially in section of the two ferrule arrangement of FIG. 10;

FIG. 12 is an end cross sectional view of the arrangement of FIG. 11 as taken along lines 12-12 thereof;

FIG. 13 depicts the two segment portion of the stock of FIG. 10 after separation;

FIG. 14 shows an apparatus which is used to implement the connective arrangement of this invention; and

FIG. 15 shows schematically a three rod alignment means used in a connective arrangement of this invention.

Detailed Description

Referring now to FIG. 1, there is shown a polarization-maintaining optical fiber 20. The polarization-maintaining optical fiber 20 includes a core 22 and a plurality of cladding layers. As a result of the differential thermal contraction of the layers, stress-induced birefringence is caused when the preform tube is col-

lapsed. An outer cladding layer 23 has a hybrid configuration in a direction transverse to a longitudinal axis of the fiber. The hybrid configuration is such that it is defined by at least one substantially straight line. In the following description, the outer cladding layer 23 includes a rectangular portion having substantially parallel sides 27-27 and arcuately shaped end portions 28-28 each of which is connected to the two parallel sides. It should be understood that at times the end portions may have very little or substantially no curvature. About the outer cladding 23 is disposed a coating 25 (see FIG. 2) which may be a UV cured acrylate material. As can be seen in FIG. 2, the coating 25 has a circular configuration.

The polarization-maintaining fiber is manufactured to cause orthogonal polarization axes thereof to have a predetermined orientation with respect to the at least one substantially straight line which defines the outer cladding. That straight line is parallel to one of the polarization axes and hence normal to the other. In the embodiments described herein, the polarization axes have a predetermined orientation with respect to the sides 27-27 and the end portions 28-28, respectively, which define the configuration of the outer cladding layer. That orientation is such that one of the polarization axes of the optical fiber is parallel to the parallel sides 27-27 of the cross sectional configuration of the outer cladding layer 23.

Each of the fibers may be provided with a buffer layer 32 (see FIG. 2) of PVC for example, and a strength member 33 such as one made of KEVLAR® fibrous material, for example. An outer jacket 35 which may be comprised of PVC (see FIG. 2) encloses the buffer layer 32. The completed structure is referred to as a single fiber cable and is designated by the numeral 37.

Referring now to FIGS. 3-4 there is shown a portion of one device 30 which is used to terminate a polarization-maintaining optical fiber and facilitate the mechanical connection of two polarization-maintaining optical fibers. The device 30 may be referred to as a termination device.

A connection comprises two optical fiber termination assemblies each including a termination device 30 and an end portion of a length of polarization-maintaining optical fiber. Corresponding elements of the termination assemblies are identified with the same numerals. The connection is such that longitudinal axes 36-36 of the termination devices are coaxial. In addition to an end portion of an optical fiber 20, each termination assembly comprises an optical fiber ferrule or plug 40, having a passageway 41 (see FIG. 1 and 4) and being made of a glass or ceramic material, for example. The passageway 41 has a cross section which is defined by at least one straight side, and generally has a configuration similar to that of the optical fiber end portion received therein. In the embodiments described herein, the passageway 41 has a cross-section transverse to a longitudinal axis of the ferrule which is substantially rectangular (see FIG. 1 and 5) and which is at least slightly larger than the largest expected transverse cross-section of uncoated optical fiber to be terminated therewith. The passageway 41 is defined by long sides 38-38 and by short sides 39-39. Corners of walls which define the passageway are formed with a slight radius which is substantially less than the radii of the end portions 28-28 of the outer cladding layer of the optical fiber. The ferrule 40 has an outer diameter of about 2500 μm. An end face 34 of the plug 40 includes an opening of the passageway 41.

In terminating a cable 37, the coating 25, as well as the buffer layer 32, strength member 33 and outer jacket 35, is removed from an end portion of an optical fiber 20 prior to its termination with a ferrule 40. Then a hybrid-shaped, uncoated end portion of optical fiber is inserted into the rectangular passageway 41 of each ferrule 40. The end portion of the optical fiber 21 is secured within the passageway 41 of the ferrule 40 in accordance with this invention and the end faces of the optical fiber and of the ferrule are ground and polished.

Each termination assembly also includes a connector body 42 (see FIGS. 3-4) made of a plastic or metallic material, a compression spring 44 and a tubular housing 45 made of a metallic material. It should be noted that the ferrule 40, the connector body 42 and the housing 45 each has a cylindrical cross-section.

The connector body 42 includes a separate orienting means such as a key or tab 43 (see also FIG.1), for example, which projects radially from the longitudinal axis 36. Importantly, the tab 43 is oriented to be normal to the long sides 38-38 of the rectangular passageway 41 and hence is normal to the parallel sides 27-27 of the polarization-maintaining fiber 20.

The connector body 42 includes a small diameter portion 46 (see FIG. 4) which extends through an opening 47 in an internally disposed collar 48 in the housing. A retaining washer 49 circumscribes the small diameter portion on the outer side of the collar. The spring 44 is disposed about the smaller diameter portion 46 of the connector body 42 between the collar 48 and a large diameter portion 51. As a result of this arrangement, the spring 44 biases the connector body 42 outwardly from the cable to hold the connector body within the housing 45.

Viewing now FIG. 6 which shows a connector 50, it can be seen that the housing 45 may include a longitudinally extending slot 55 which at its inner end communicates with a circumferentially extending slot 57. The slot 57 is formed so that the tubular wall of the housing which defines it includes a latching projection 58. These slots 55 and 57 are used for securing a termination device 30 to another portion of the connec-

tor.

Completing each connector termination device 30 as is shown in FIG. 6 is a portion 59 which may extend from the housing 45 along the optical fiber cable in a conically shaped configuration. This portion of the connector 50 provides strain relief for the termination and ensures that the cable can withstand repeated bends in use after interconnection with another cable without undue stresses being imparted to the optical fibers.

A polarisation-maintaining optical fiber 20 is prepared for termination with a ferrule 40 by removing the coating from an end portion of the fiber. The end portion of the optical fiber is then inserted and secured in one of the ferrules having a designated direction of eccentricity by suitable means such as, for example, by an adhesive, preferably a UV-curable adhesive 52 (see FIG. 1). The portion of the optical fiber which protrudes from an end face of the ferrule (see FIGS. 3 and 4) is scribed and broken after which the optical fiber and ferrule end faces are polished by techniques well known in the art.

In accordance with this invention, steps are taken to reduce loss attributed to misalignment of fiber axes and to eccentricity of the optical fiber within the rectangular ferrule passageway 41 because the transverse cross section of the ferrule passageway is slightly larger than the largest transverse cross section of an optical fiber to be received therein. The ferrule passageway may have dimensions that are as much as about 5 µm larger than those of the polarization-maintaining optical fiber end portion received therein. Generally, each side of the rectangular passageway is about 3 µm greater than the corresponding side of the polarization-maintaining fiber. In a preferred embodiment, the ferrules are made with the passageways having a short side of about 74 µm and a long side of about 143 µm to accommodate optical fiber having a transverse cross section with overall outer dimensions of about 70 µm by 140 µm. As a result of these tolerances in passageway cross section, costs are reduced.

Suitable alignment is accomplished first by causing the outer cladding layer of the polarization-maintaining fiber to have the hereinbefore-described hybrid configuration transverse to the longitudinal axis of the optical fiber. An end portion of the optical fiber is positioned in a passageway of a ferrule (see FIG. 7), the passageway having a rectangular configuration which is larger than that of the fiber received therein. The positioning is such that the long sides 27-27 of the optical fiber cladding layer 23 are parallel to the long sides 38-38 of the passageway 41. Then as mentioned hereinbefore the ferrule is provided with a tab 43 such that the tab extends radially of the ferrule and such that it is perpendicular to the long side 38 of the rectangular passageway 41 in the ferrule. In general, the tab 43 is in a predetermined angular orientation with respect to at least one straight side which defines the passageway and hence in a predetermined orientation with respect to the at least one straight side of the hybrid configuration of the outer cladding layer of the optical fiber end portion disposed therein and to the polarization axes of the optical fiber end portion.

Further, the optical fiber end portion is caused to be disposed within the passageway 41 in a predetermined orientation with respect to the passageway and with respect to the direction of any eccentricity of the passageway in which it is disposed. In a preferred embodiment, should the passageway be disposed eccentrically as shown in FIG. 5, then the end portion of the optical fiber 20 is caused to be biased in the oversize passageway toward the outermost long side 38 of the ferrule passageway (see FIG. 7). Of course, it should be understood that the predetermined orientation could be such that the optical fiber is biased against the wall of the passageway in a direction opposite to the direction of eccentricity. What is important is that each ferrule which is used in the connection have the optical fiber end portion in its associated passageway in the same orientation with respect to the oversize passageway and to the direction of any eccentricity as that of the other ferrule to be connected thereto. That orientation may be predetermined by determining the direction of eccentricity of the ferrule passageway prior to securing the optical fiber end portion therein. Further, each optical fiber end portion also is caused to be biased toward a short side of the passageway in which it is disposed (see FIG. 8). Each fiber is terminated so that it is biased in the same direction toward the same short side 39 of the rectangular passageway.

Two of the devices 30-30 are supported with their axes 36-36 being coaxial. Should the tabs 43-43 be aligned and should the fibers in the passageways be aligned, extinction ratio degradation and transmission loss are minimized. It will be observed that if the tabs 43-43 are aligned, then the passageways 41-41 of the two devices are such that the optical fiber end portions therein are aligned.

Each of the connector bodies 42-42 and ferrules 40-40 is adapted to be received in a coupling designated generally by the numeral 60 (see FIG. 6). The coupling 60 includes a tubular member 62 having end portions 64 and 66 with each end portion including a longitudinally extending slot 67. In order to allow the connector 20 to be panel-mountable, the coupling 60 includes a center portion 68 which is threaded and which is adapted to be inserted into a hole (not shown) in a panel. Also included in the coupling 60 at each end portion 64 and 66 thereof are assembly pins 73-73 which are displaced circumferentially from the slot 67 at that end. See also U.S. patents 4,738,507 and 4,738,508.

In assembling the connector 50 which is shown in

FIG. 6, an installer panel-mounts the coupling 60 or otherwise positions it to receive the termination devices 30-30. Mounted within the coupling 60 is a sleeve 75. The sleeve 75 is provided with a longitudinal slit through the wall thereof and is adapted to receive the ferrules 40-40 of the termination devices 30-30 and is a means for aligning the outer surfaces of the plugs. The sleeve 75 is disposed within the coupling 60 such that it floats to allow for some movement of the ferrules 40-40 when they are inserted into the coupling. Further, the sleeve 75 causes the longitudinal axes 36-36 of the ferrules 40-40 mounted therein to be coaxial.

An installer, in assembling the connector 50, inserts the ferrule 40 of one of the terminations devices 30-30 into the sleeve 75 with the pin 73 of the coupling being received in the longitudinally extending slot 55 of the termination device. At the same time, the installer has caused the tab 43 which extends radially from the connector body 42 of the one termination device 30 to be received in a longitudinal slot 67 of the coupling 60. The movement of the ferrule 40 is discontinued when the tab 43 engages an inner end of the wall which defines the slot 67. Continued movement of the housing 45 against the bias of the spring 44 causes the housing to override the connector body. When the pin 73 at the one end of the coupling 60 reaches an inner end of the longitudinally extending slot 55, the operator turns the housing 45 to cause the pin 73 to become disposed and secured within the circumferentially extending slot 57 behind the latching portion 58 (see FIG. 6). It should be observed that the housing 45 is free to turn about the plug 40 and its associated connector body 42. This allows the housing 45 to be turned independently of the connector body 42 to cause the pin 73 to become disposed behind the latching portion 58.

After these steps, the installer repeats foregoing the procedure with respect to the other termination device 30 to cause the ferrule 40 thereof to be received within the floating sleeve 75. The geometries of the coupling 60 and of the terminations 37-37 are such that when the ferrules 40-40 are received within the floating sleeve 75, and the tabs 43-43 bottomed out in the slots 67-67 of the coupling 60, end faces of the ferrrules 40-40 may abut each other. Also, with the pins 43-43 aligned, the polarization axes of the optical fiber end portions have the same predetermined orientation with respect to the ferrule passageways. As a result, transmission losses and extinction ratio degradation through the connector 50 are minimized.

In a preferred embodiment, the ferrules are those of a prealigned rotary splice connector disclosed and claimed in priorly identified U.S. patent 4,691,986, which is incorporated by reference hereinto. Ferrules to be used in a connector are made from contiguous portions of a length of tubular stock 90 having a rectangular passageway 92 (see FIG. 9). As can be seen in FIG. 9, there are markings 94,96 and 98 by which contiguous end faces of contiguous segments can be identified at a later time. The tubular stock 90 also includes means for identifying the angular relationship between contiguous ferrules, such as a line 100 or a groove 101 (see FIG. 9) that extends parallel to a longitudinal axis 102 of the stock. The line 100 or groove 101 need not extend the lengths of the segments. Ferrule segments can be identified by means of a short line that crosses the boundary between the segments. Such a line also would serve to identify the contiguous ends of contiguous ferrule segments. Further, although in the currently preferred embodiment, the ferrule segments are drawn glass, the invention is not so limited and the tubular stock may be made from any suitable material including ceramic, plastics or metal, for example, and shaped by processes other than drawing.

Two ferrule segments 104, 106 (see FIG. 9) which are contiguously located in the tubular stock are used for a connector. Care also is taken that the end faces of the ferrule segments in which the optical fibers terminate are contiguous prior to separation of the ferrule segments from the tubular stock. The rotational markings on the ferrule segments permit rotational alignment of the ferrules after termination. As will be recalled, each marking means is normal to the long parallel sides of the passageway, and hence to the long side of the polarization-maintaining fiber outer cladding and to one of its polarization axes. As a result, the polarization-maintaining axes of the two fibers are aligned.

The preferred embodiment of this invention will be described with respect to FIGS. 10-14. Therein, a length 110 of tubular stock material such as drawn glass, for example, comprising two ferrule segments 111-111 is terminated at each of its ends by a housing 112 (see FIG. 10) which typically is made of a plastic material such as polycarbonate. It should be observed that the preform has a circumferential V-groove 113 formed about its center plane. The housing 112 includes a cavity 114 (see FIG. 11) for receiving an end portion 115 of the stock length 110 and includes a small diameter portion 116. The small diameter portion 116 includes a passageway 118 which communicates with a tapered transition 119 from an enlarged passageway 121. The enlarged passageway 121 is adapted to receive an end portion of a buffered optical fiber to be terminated and from an end portion of which the buffer layer has been removed to expose an end portion of optical fiber. When the buffered optical fiber is received in the enlarged passageway 121, the exposed portion of the optical fiber extends through the transition section 119 and passageway 118 into a substantially rectangular passageway 122 (see FIG. 12) of ferrule segment 111.

The housing 112 also includes an enlarged por-

tion 124 which is provided with a tab 126. During assembly of the housings 112-112 onto the end portions of the stock length 110, the housings are turned to cause the tabs to be aligned longitudinally.

Each tab 126 is attached to an associated segment in a predetermined manner. In the preferred embodiment, each tab 126 is attached to a segment to cause the tab to be perpendicular to the long side of the rectangular configuration of the passageway. As a result, when an end portion of the optical fiber 20 without its coating is disposed in the passageway, the tab 126 will be normal to parallel sides of the hybrid configuration of the outer cladding layer and hence normal to one of the polarization axes of the optical fiber.

Over a free end of each small diameter portion 116 is positioned a collar 128. A compression spring 129 is disposed concentrically about the small diameter portion 116 between the collar 128 and the enlarged portion of the housing and is adapted to snap-lock over a lip 125 of the housing 112.

Afterwards, two of the marked ferrule segments 111-111 with housings 112-112 mounted thereon are separated from each other along the circumferential groove 113 and are used to terminate two optical fibers (see FIG. 13). As emphasized hereinbefore, the terminations are such that the end faces in which the optical fibers terminate were contiguous to each other when the ferrule segments were unseparated portions of the stock (see FIG. 10).

Also, the terminations are carried out so that each fiber end portion is disposed within its associated plug passageway in a predetermined orientation with respect to the direction of eccentricity of the passageway, as described hereinbefore. In the preferred embodiment, the end portion of each optical fiber is inserted into the passageway 122 of its associated ferrule segment 111 and biased in the direction of the tab 126 of the housing 112 in which the plug is mounted, that is toward the outside of the ferrule along a radial line that extends from the longitudinal centroidal axis of the ferrule through the tab 126. Also, each fiber end portion is positioned so that it is biased toward the same short side of the passageway as viewed from an end face of the fiber end portion (see FIG. 8).

An apparatus of this invention may be useful to position each optical fiber end portion in the passageway of a ferrule segment 111. Such an apparatus 130 may be one which is shown in FIG. 14 and which may be used to position simultaneously each of a plurality of fiber end portions in the same orientation with respect to passageways in associated ferrules. Each of a plurality of ferrule segments 111-111 which are mounted in housings 112-112 and which had been contiguous pairs from the same length 110 is positioned in a nest 132 in the apparatus 130. Each is positioned so that the tab 126 along each housing is received in a keyway 134 of the associated nest received therein. As can be seen in FIG. 14, the keyway 134 of each nest is oriented downwardly.

At this time, a curable adhesive material is injected by a syringe (not shown), for example, into each ferrule passageway. Such an adhesive may be UV-curable.

Then, an end portion of an optical fiber 20 which has had the coating 25 removed therefrom is inserted into one of the ferrule segments held in the apparatus 130. This step is repeated until each of the ferrules is provided with adhesive and an end portion of an optical fiber in its passageway.

As can be seen in FIG. 14, the apparatus is provided with a plurality of pivotally mounted wire-like bails 138-138. Each bail 138 is arranged so that a central portion thereof spans transversely an aligned optical fiber end portion of an aligned nest. The bails are supported from pintles 142-142 attached to a rod 144. A knob 146 is attached to an end of the rod 144. The bails are caused to be moved simultaneously pivotally by the turning of the knob 146 to engage the plurality of optical fibers adjacent to their entrances into the ferrules and then moved further to move the optical fiber end portions in the rectangular passageways into engagement with the lowermost long sides of the passageways as viewed in FIG. 8. It should be remembered that in such a position, each optical fiber is oriented in the direction of the tab 126 on the exterior surface of the housing 112 of the ferrule segment. Also, it will be recalled that the tab 126 is normal to the parallel sides of the outer cladding layer of the optical fiber. Because the tab 126 of each ferrule segment is in the same orientation with respect to the direction of any eccentricity of the passageway through the ferrule segment, the optical fiber end portion within the passageway of a ferrule segment is in the same orientation with respect to passageway eccentricity as is the optical fiber end portion within the passageway of another ferrule segment of the same tubular stock.

Afterwards, each optical fiber is caused to be moved to cause it to engage with one of the short sides of the associated passageway (see FIG. 8). In a next step of making the connection, the adhesive material in each passageway is cured. The bails 138-138 are maintained in their moved positions, holding the optical fiber end portions in the lowermost portions of the passageways. Then the apparatus 130 is exposed to curing radiation such as UV energy to cure and harden the adhesive material in each passageway. As a result, each optical fiber end portion remains in its passageway in the same orientation with respect to the passageway.

It should be apparent that should the optical fibers be disposed in the ferrule passageways and biased toward the tabs 126-126, then the fibers each have the same orientation with respect to any eccentricity of the ferrule passageways relative to the cen-

troidal axes of the ferrules. In the preferred embodiment, the direction of eccentricities has not been determined because the ferrule segments have the same rotational alignment relative to each other after separation from each other as before separation. The tab 126 of each may be in any orientation with respect to any eccentricity of its ferrule passageway; what is important is that both tabs have the same orientation. As a result, the eccentricity component attributed to the eccentricity of an optical fiber end portion with respect to an oversize passageway in which it is positioned has been eliminated substantially.

Further, the apparatus 130 is useful even if there is no passageway eccentricity. The invention allows the use of an oversize passageway as described hereinbefore and ferrule segments are arranged such that the optical fiber in the passageway of each has the same orientation with respect to the ferrule passageway and hence with respect to the tab 126.

The splicing of the two optical fibers then is completed by inserting the two ferrule segments into a suitable alignment device. One such alignment device which is preferred is disclosed in U.S. patent 4,545,644. The use of a prealigned rotary splice which includes the use of contiguous ferrule segments from the same tubular stock mounted in the alignment device of U.S. patent 4,545,644 is disclosed in priorly identified U.S. patent 4,691,986.

A multi-rod alignment device 150 (see FIG. 15) such as is shown in the above-identified U.S. patents 4,545,644 and 4,691,986 includes three cylindrical alignment rods 152, 154 and 156 which are held within a flexible clip 158 such that the rods engage the ferrules after their insertion into the alignment means. It is desirable that the alignment rods have substantially the same coefficient of thermal expansion as the segments. The alignment rods 152, 154, and 156 may be turned to tune further the two ferrule segments 111-111 held within the alignment device 150.

Connectors according to the invention also comprise means for maintaining a constant axial relationship between the fiber ends after the insertion of the plugs into the alignment means. Facilities for doing this are well known in the art and are not disclosed herein. Such facilities may include an organizer into which the ferrule assemblies and alignment device 150 is inserted. The organizer is such that insertion of the assembly requires movement of each collar toward its associated housing and attendant compression of the associated spring. It should be understood that the axial relationship can be such that the ferrule end faces are in contacting relationship with each other or spaced apart with an index matching material therebetween.

The groove 101 (see FIG. 9) which is formed longitudinally along the tubular stock 90 prior to separation of the ferrule segments, e.g. 111 and 111, from the stock may be used to identify the angular relationship between the contiguous ferrules. The groove facilitates the rotational alignment of the ferrules without visual observation. For example, when using the alignment rods of U.S. patent 4,545,644, the first ferrule segment 111 is inserted among the alignment rods such that one of the rods contacts the first ferrule along its groove. After the second ferrule segment 111 is inserted, it is turned rotatably until the same alignment rod contacts the second ferrule along its groove. This latter alignment may be signaled by a click that occurs as the rod enters the groove.

Claims

1. A connection between two polarization-maintaining optical fibers (20), said connection comprising

   first and second fiber supports (40) each having an associated longitudinal passageway (41) extending therethrough and opening to an end face of the support, each said longitudinal passageway having a cross section transverse to its longitudinal axis which is substantially rectangular (38,39);

   two polarization-maintaining optical fibers (20) each having an end portion disposed in the passageway of a respective one of said supports, each said optical fiber having an outer cladding (23) which has a hybrid outer configuration which in a cross section transverse to its longitudinal axis is defined by two ends (28) and by two substantially parallel sides (27) such that said two parallel sides of said hybrid configuration are substantially parallel to one of the two orthogonal polarization axes of said each optical fiber, each said optical fiber end portion being disposed in its associated passageway so that its parallel sides (27) are substantially parallel to the long sides (38) of said rectangular passageway, whereby said long sides are also substantially parallel to said one of said two orthogonal polarization axes of said each optical fiber;

   marking means (43) associated with each said support and disposed in a predetermined orientation with respect to said long sides (38) of said rectangular passageway of said each support, and therefore with respect to the parallel sides (27) of the hybrid configuration of said fiber end portion disposed in the passageway of said each support and with respect to said one of said polarization axes of said each optical fiber, said predetermined orientation being the same for both supports; and

   alignment means (42) for holding said first and second supports to cause said marking means of said supports to be aligned longitudinally and hence to cause the polarization axes of

one fiber end portion to be parallel to the polarization axes of the other fiber end portion, said connection being characterized in that

each of said first and second fiber supports (40) is constituted by a ferrule, and

the transverse cross section (38,39) of each said passageway (41) in each said ferrule is larger than the largest expected transverse cross section (27,28) of an optical fiber end portion to be received therein and each said optical fiber end portion is secured within its associated passageway, in a manner such that the optical fiber is maintained in contact in a predetermined location against the wall of the associated passageway, said predetermined location being the same for both ferrules; whereby said optical fiber end portions so received and secured in their associated passageways are, despite their eccentric positioning in said passageways, substantially longitudinally aligned, and with their polarization axes substantially angularly aligned with one another, when said ferrules (40) are maintained in said alignment means (42) with their marking means (43) longitudinally aligned.

2. The connection of claim 1, wherein said marking means (43) is normal to the long sides (38) of said rectangular passageway (41) of said each support (40), and therefore normal to the parallel sides (27) of the hybrid configuration of the optical fiber end portion.

3. The connection of claim 1, wherein each of said ferrules (40) is obtainable by cutting off a segment (111) of a tubular stock (104), wherein the segments of said stock for said first and second ferrules are continguous portions of said stock and such that contiguous end faces of the two portions of the stock which are to become said first and second ferrules are adjacent free end faces of the first and second ferrules and wherein each of said ferrules prior to separation from each other has a free end thereof received in a cavity of a housing (112), said housing including a large diameter portion and a small diameter portion, said housing having a passageway therethrough which is aligned with said passageway in its associated ferrule segment when said ferrule segment is mounted therein, each said housing also including a tab (126) as said marking means and said housings being assembled to said ferrule segments to cause the tabs on said housings to be aligned longitudinally.

4. A polarization-maintaining optical fiber termination which is adapted to be connected to another polarization-maintaining optical fiber termination, said polarization-maintaining optical fiber termination comprising:

a fiber support (40) having an associated longitudinal passageway extending therethrough and opening to an end face of the support, said longitudinal passageway having a cross section transverse to its longitudinal axis which is substantially rectangular (38,39);

a polarization-maintaining optical fiber (20) having an end portion disposed in the passageway of said support, said optical fiber having an outer cladding (23) which has a hybrid outer configuration which in a cross section transverse to its longitudinal axis is defined by two ends (28) and by two substantially parallel sides (27) such that said two parallel sides of said hybrid configuration are substantially parallel to one of the two orthogonal polarization axes of said optical fiber, said optical fiber end portion being disposed in its associated passageway so that its parallel sides (27) are substantially parallel to the long sides (38) of said rectangular passageway, whereby said long sides are also substantially parallel to said one of said two orthogonal polarization axes of said optical fiber; and

marking means (43) associated with said support and disposed in a predetermined orientation with respect to said long sides (38) of said rectangular passageway of said support, and therefore with respect to the parallel sides (27) of the hybrid configuration of said fiber end portion disposed in the passageway of said support, and with respect to said one of said polarization axes of said optical fiber, for facilitating the alignment of said polarization-maintaining optical fiber with another polarization-maintaining optical fiber; said termination being characterized in that

said fiber support (40) is constituted by a ferrule, and

the transverse cross section (38,39) of said passageway (41) in said ferrule is larger than the largest expected transverse cross section (27,28) of an optical fiber end portion to be received therein and said optical fiber end portion is secured within its associated passageway, in a manner such that the optical fiber is maintained in contact in a predetermined location against the wall of the associated passageway, thereby facilitating the longitudinal and angular alignment of said polarization-maintaining fiber with another polarization-maintaining fiber.

5. The optical fiber termination of claim 4, which also includes a housing (51) in which said ferrule (41) is mounted, wherein said marking means (43) is provided on said housing and said optical fiber end portion is disposed in said passageway (49) of said ferrule (40) in a direction which extends radially through said marking means, and

wherein said marking means includes a tab which is normal to the long sides (38) of the passageway, and therefore normal to the parallel sides (27) of the hybrid cross section of the polarization-maintaining optical fiber.

Patentansprüche

1. Verbindung zwischen zwei polarisationserhaltenden optischen Fasern (20), die folgendes umfaßt:

   eine erste und zweite Faserstütze (40), die jeweils einen ihnen zugeordneten und durch sie verlaufenden Längsdurchgang (41) aufweisen, der sich zu einer Stirnfläche der Stütze hin öffnet, wobei jeder der besagten Längsdurchgänge einen quer zu seiner Längsachse liegenden Querschnitt aufweist, der im wesentlichen rechteckig (38, 39) ist;

   zwei polarisationserhaltende optische Fasern (20), die jeweils einen im Durchgang einer jeweiligen der besagten Stützen angeordneten Endteil und einen äußeren Mantel (23) aufweisen, der eine gemischte Außenkonfiguration aufweist, die in einem quer zu ihrer Längsachse liegenden Querschnitt von zwei Enden (28) und zwei im wesentlichen parallelen Seiten (27) definiert wird, so daß die beiden besagten parallelen Seiten der besagten gemischten Konfiguration im wesentlichen parallel zu einer der beiden orthogonalen Polarisationsachsen jeder der besagten optischen Fasern liegen, wobei jeder besagte Endteil der optischen Fasern in seinem zugehörigen Durchgang so angeordnet ist, daß seine parallelen Seiten (27) im wesentlichen parallel zu den Längsseiten (38) des besagten rechteckigen Durchgangs liegen, wodurch die besagten Längsseiten auch im wesentlichen parallel zu der besagten der beiden besagten orthogonalen Polarisationsachsen jeder besagten optischen Faser liegen;

   Markierungsmittel (23), die jeder besagten Stütze zugeordnet und in einer vorbestimmten Ausrichtung gegenüber den Längsseiten (38) des besagten rechteckigen Durchgangs jeder besagten Stütze und deshalb auch gegenüber den parallelen Seiten (27) der gemischten Konfiguration des im Durchgang jeder besagten Stütze angeordneten besagten Faserendteils und gegenüber der besagten einen der besagten Polarisationsachsen jeder besagten optischen Faser angeordnet sind, wobei die besagte vorbestimmte Ausrichtung für beide Stützen gleich ist; und

   Ausrichtemittel (42) zum Halten der besagten ersten und zweiten Stütze, damit die besagten Markierungsmittel der besagten Stützen in Längsrichtung ausgerichtet sind und die Polarisationsachsen eines Faserendteils somit parallel zu den Polarisationsachsen des anderen Faserendteils liegen, wobei die Verbindung dadurch gekennzeichnetist, daß

   sowohl die besagte erste als auch die besagte zweite Faserstütze (40) aus einer Führungshülse besteht und

   der in Querrichtung liegende Querschnitt (38, 39) jedes besagten Durchgangs (41) in jeder besagten Führungshülse größer ist als der größte erwartete in Querrichtung liegende Querschnitt (27, 28) eines darin aufzunehmenden Endteils einer optischen Faser und jeder besagte Endteil der optischen Faser in seinem zugehörigen Durchgang so befestigt ist, daß die optische Faser an einer vorbestimmten Stelle mit der Wand des zugehörigen Durchgangs in Berührung gehalten wird, wobei die vorbestimmte Stelle für beide Führungshülsen die gleiche ist; wodurch die so in ihren zugehörigen Durchgängen aufgenommenen und befestigten besagten Endteile der optischen Fasern trotz ihrer exzentrischen Positionierung in den besagten Durchgängen im wesentlichen in Längsrichtung ausgerichtet sind und ihre Polarisationsachsen im wesentlichen winkelförmig aufeinander ausgerichtet sind, wenn die besagten Führungshülsen (40) so in den besagten Ausrichtemitteln (42) gehalten werden, daß ihre Markierungsmittel (43) in Längsrichtung ausgerichtet sind.

2. Verbindung nach Anspruch 1, bei der das besagte Markierungsmittel (43) senkrecht zu den Längsseiten (38) des besagten rechtwinkligen Durchgangs (41) jeder besagten Stütze (40) und deshalb senkrecht zu den parallelen Seiten (27) der gemischten Konfiguration des Endteile der optischen Faser steht.

3. Verbindung nach Anspruch 1, bei der jede der besagten Führungshülsen (40) durch Abschneiden eines Segments (111) eines röhrenförmigen Rohlings (104) erhalten werden kann, bei der die Segmente des besagten Rohlings für die erste und zweite Führungshülse aneinander angrenzende Teile des besagten Rohlings sind, und zwar derart, daß aneinander angrenzende Stirnflächen der beiden Teile des Rohlings, aus denen die besagte erste und zweite Führungshülse gebildet wird, benachbarte freie Stirnflächen der ersten und zweiten Führungshülse sind, und bei der ein freies Ende jeder besagten Führungshülse vor ihrer Trennung voneinander in einem Hohlraum eines Gehäuses (112) aufgenommen wird, wobei das besagte Gehäuse einen Teil großen Durchmessers und einen Teil kleinen Durchmessers sowie einen Durchgang aufweist, der auf den Durchgang in seinem zugehörigen Führungshülsensegment ausgerichtet ist, wenn das

Führungshülsensegment darin befestigt ist, wobei jedes besagte Gehäuse des weiteren eine Nase (126) als das besagte Markierungsmittel aufweist und die besagten Gehäuse an den besagten Führungshülsensegmenten montiert werden, damit die Nasen an den Gehäusen in Längsrichtung ausgerichtet werden.

4. Polarisationserhaltender Abschluß einer optischen Faser, der zur Verbindung mit einem anderen polarisationserhaltenden Abschluß einer optischen Faser ausgeführt ist, wobei der besagte polarisationserhaltende Abschluß der optischen Faser folgendes umfaßt:

eine Faserstütze (40), die einen ihr zugeordneten und durch sie verlaufenden Längsdurchgang aufweist, der sich zu einer Stirnfläche der Stütze hin öffnet, wobei der besagte Längsdurchgang einen quer zu seiner Längsachse liegenden Querschnitt aufweist, der im wesentlichen rechteckig (38, 39) ist;

eine polarisationserhaltende optische Faser (20), die einen im Durchgang der besagten Stütze angeordneten Endteil und einen äußeren Mantel (23) aufweist, der eine gemischte Außenkonfiguration aufweist, die in einem quer zu ihrer Längsachse liegender Querschnitt von zwei Enden (28) und zwei im wesentlichen parallelen Seiten (27) definiert wird, so daß die beiden besagten parallelen Seiten der besagten gemischten Konfiguration im wesentlichen parallel zu einer der beiden orthogonalen Polarisationsachsen der besagten optischen Faser liegen, wobei der besagte Endteil der optischen Faser in seinem zugehörigen Durchgang so angeordnet ist, daß seine parallelen Seiten (27) im wesentlichen parallel zu den Längsseiten (38) des rechteckigen Durchgangs liegen, wodurch die besagten Längsseiten auch im wesentlichen parallel zu der besagten der beiden besagten orthogonalen Polarisationsachsen der besagten optischen Faser liegen;

Markierungsmittel (43), die der besagten Stütze zugeordnet und in einer vorbestimmten Ausrichtung gegenüber den Längsseiten (38) des besagten rechteckigen Durchgangs der besagten Stütze und deshalb auch gegenüber den parallelen Seiten (27) der gemischten Konfiguration des im Durchgang der besagten Stütze angeordneten besagten Faserendteils und gegenüber der besagten einen der besagten Polarisationsachsen der besagten optischen Faser angeordnet sind, um die Ausrichtung der besagten polarisationserhaltenden optischen Faser auf eine andere polarisationserhaltende optische Faser zu erleichtern; wobei der besagte Abschluß dadurch gekennzeichnet ist, daß

die Faserstütze (40) aus einer Führungshülse besteht und

der in Querrichtung liegende Querschnitt (38, 39) des besagten Durchgangs (41) in der besagten Führungshülse größer ist als der größte erwartete in Querrichtung liegende Querschnitt (27, 28) eines darin aufzunehmenden Endteils einer optischen Faser und der besagte Endteil der optischen Faser in seinem zugehörigen Durchgang so befestigt ist, daß die optische Faser an einer vorbestimmten Stelle mit der Wand des zugehörigen Durchgangs in Berührung gehalten wird, wodurch die Ausrichtung in Längsrichtung und die winkelförmige Ausrichtung der besagten polarisationserhaltenden Faser zu einer anderen polarisationserhaltenden Faser erleichert wird.

5. Abschluß einer optischen Faser nach Anspruch 4, der des weiteren ein Gehäuse (51) enthält, in dem die besagte Führungshülse (41) befestigt ist, bei dem das besagte Markierungsmittel (43) an dem besagten Gehäuse vorgesehen ist und der besagte Endteil der optischen Faser in dem besagten Durchgang (49) der besagten Führungshülse (40) in einer Richtung angeordnet ist, die radial durch das besagte Markierungsmittel verläuft, und bei dem das besagte Markierungsmittel eine Nase enthält, die senkrecht zu den Längsseiten (38) des Durchgange und deshalb auch senkrecht zu den parallelen Seiten (27) des gemischten Querschnitts der polarisationserhaltenden optischen Faser steht.

Revendications

1. Connexion entre deux fibres optiques (20) à polarisation unique, ladite connexion comprenant

un premier et un deuxième supports (40) de fibre chacun comportant un passage longitudinal (41) associé s'étendant à travers lui et débouchant sur une face d'extrémité du support, chacun desdits passages longitudinaux ayant une section transversale en travers de son axe longitudinal qui est substantiellement rectangulaire (38, 39);

deux fibres optiques (20) à polarisation unique, chacune comportant une partie d'extrémité disposée dans le passage de l'un respectif desdits supporte, chaque dite fibre optique ayant un revêtement externe (23) qui a une configuration externe hybride qui, dans une section transversale en travers de son axe longitudinal, est définie par deux extrémités (28) et par deux côtés (27) substantiellement parallèles de sorte que lesdits deux côtés parallèles de ladite configuration hybride soient substantiellement parallèles à l'un des deux axes de polarisation orthogonaux de chaque dite fibre optique, chaque dite partie

d'extrémité de la fibre optique étant positionnée dans son passage associé de sorte que ses côtés parallèles (27) soient substantiellement parallèles aux longe côtés (38) dudit passage rectangulaire, en conséquence de quoi lesdits longs côtés sont aussi substantiellement parallèles à l'undit desdits deux axes de polarisation orthogonaux de chaque dite fibre optique;

un moyen de repérage (43) associé avec chaque dit support et disposé selon une orientation prédéterminée par rapport auxdits longs côtés (38) dudit passage rectangulaire de chaque dit support, et donc par rapport aux côtés parallèles (27) de la configuration hybride de ladite partie d'extrémité de la fibre positionnée dans le passage de chaque dit support et par rapport à l'undit desdits axes de polarisation de chaque dite fibre optique, ladite orientation prédéterminée étant la même pour les deux supports; et

un moyen d'alignement (42) pour maintenir lesdits premier et deuxième supporte pour inciter lesdits moyens de repérage desdits supporte à s'aligner longitudinalement et par suite pour inciter les axes de polarisation d'une partie d'extrémité de la fibre à se mettre en parallèle avec les axes de polarisation de l'autre partie d'extrémité de la fibre, ladite connexion étant caractérisée en ce que

chacun desdits premier et deuxième supports (40) de fibre est constitué par un embout, et

la section transversale (38, 39) en travers de chaque dit passage (41) dans chaque dit embout est plus grande que la plus grande section transversale en travers (27, 28) envisagée d'une portion d'extrémité de fibre optique devant y être logée et chaque dite partie d'extrémité de fibre optique est fixée à l'intérieur de son passage associé, de telle manière que la fibre optique est maintenue en contact à un endroit prédéterminé contre la paroi du passage associé, ledit endroit prédéterminé étant le même pour les deux embouts; en conséquence de quoi lesdites portions d'extrémité de la fibre optique ainsi logées et fixées dans leurs passages associés sont, malgré leur positionnement décentré dans lesdits passages, alignées substantiellement longitudinalement, et avec leurs axes de polarisation alignés substantiellement angulairement l'un avec l'autre, quand lesdits embouts (40) sont conservés dans lesdits moyens d'alignement (42) avec leurs moyens de repérage (43) alignés longitudinalement.

2. Connexion de la revendication 1, dans laquelle ledit moyen de repérage (43) est normal aux longs côtés (38) dudit passage rectangulaire (41) de chaque dit support (40), et donc normal aux côtés parallèles (27) de la configuration hybride de la partie d'extrémité de la fibre optique.

3. Connexion de la revendication 1, dans laquelle chacun desdits embouts (40) peut être obtenu en coupant une section (111) d'un arbre tubulaire (104), dans lequel les sections dudit arbre pour lesdits premier et deuxième embouts sont des parties contiguës dudit arbre et telles que les faces d'extrémité contiguës des deux parties de l'arbre qui doivent devenir lesdits premier et deuxième embouts sont des faces adjacentes d'extrémités libres des premier et deuxième embouts et dans lequel chacun desdits embouts antérieurement à la séparation l'un d'avec l'autre a une de ses extrémités libres logée dans une cavité d'un logement (112), ledit logement comprenant une partie de grand diamètre et une partie de petit diamètre, ledit logement comportant un passage à travers lui qui est aligné avec ledit passage dans sa section d'embout associée quand ladite section d'embout est montée dedans, chaque dit logement comprenant aussi un panneton (126) en tant que dit moyen de repérage et lesdits logements étant assemblés avec lesdites sections d'embout pour faire s'aligner longitudinalement les pannetons sur lesdits logements.

4. Terminaison de fibre optique à polarisation unique qui est adaptée pour être connectée à une autre terminaison de fibre optique à polarisation unique, ladite terminaison de fibre optique à polarisation unique comprenant:

un support de fibre (40) comportant un passage longitudinal associé s'étendant à travers lui et débouchant sur une face d'extrémité du support, ledit passage longitudinal comportant une section transversale en travers de à son axe longitudinal qui est substantiellement rectangulaire (38, 39);

une fibre optique à polarisation unique (20) comportant une partie d'extrémité positionnée dans le passage dudit support, ladite fibre optique comportant un revêtement externe (23) qui a une configuration externe hybride qui, dans une section transversale en travers de son axe longitudinal, est définie par deux extrémités (28) et par deux côtés (27) substantiellement parallèles de sorte que lesdits deux côtés parallèles de ladite configuration hybride soient substantiellement parallèles à l'un des deux axes de polarisation orthogonaux de ladite fibre optique, ladite partie d'extrémité de fibre optique étant positionnée dans son passage associé de sorte que ses côtés parallèles (27) soient substantiellement parallèles aux longs côtés (38) dudit passage rectangulaire, en conséquence de quoi lesdits longs côtés sont aussi substantiellement parallèles à

l'undit desdits deux axes de polarisation orthogonaux de ladite fibre optique; et

un moyen de repérage (43) associé avec ledit support et positionné avec une orientation prédéterminée par rapport auxdits longs côtés (38) dudit passage rectangulaire dudit support, et donc par rapport aux côtée parallèles (27) de la configuration hybride de ladite partie d'extrémité de fibre positionnée dans le passage dudit support et par rapport à l'undit desdits axes de polarisation de ladite fibre optique, pour faciliter l'alignement de ladite fibre optique à polarisation unique avec une autre fibre optique à polarisation unique; ladite terminaison étant caractérisée en ce que

ledit support (40) de fibre est constitué par un embout, et

la section transversale (38, 39) en travers dudit passage (41) dans ledit embout est plus grande que la plus grande section transversale en travers (27, 28) envisagée d'une partie d'extrémité de fibre optique devant y être logée et ladite partie d'extrémité de fibre optique est fixée à l'intérieur de son passage associé, de telle manière que la fibre optique est maintenue en contact à un endroit prédéterminé contre la paroi du passage associé, facilitant ainsi l'alignement longitudinal et angulaire de ladite fibre à polarisation unique avec une autre fibre à polarisation unique.

5. Terminaison de fibre optique de la revendication 4, qui inclut aussi un logement (51) dans lequel est monté ledit embout (41), dans laquelle ledit moyen de repérage (43) est fourni sur ledit logement et ladite partie d'extrémité de fibre optique est positionnée dans ledit passage (49) dudit embout (40) selon une direction qui s'étend radialement à travers ledit moyen de repérage, et dans laquelle ledit moyen de repérage inclut un panneton qui est normal aux longs côtés (38) du passage, et donc normal aux côtés parallèles (27) de la section transversale hybride de la fibre optique à polarisation unique .

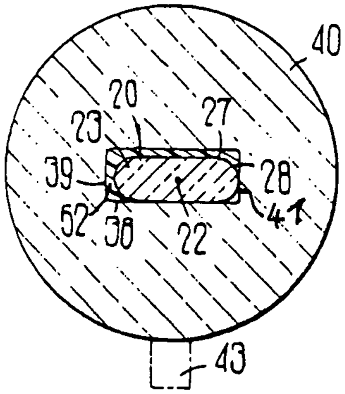

FIG 1

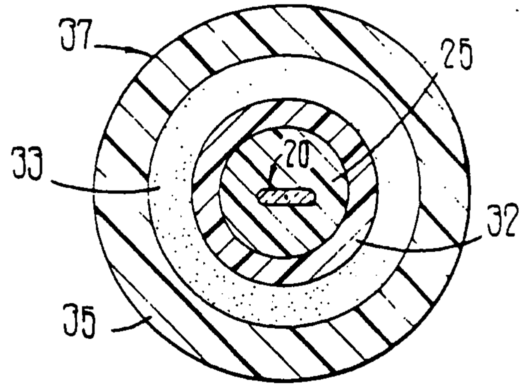

FIG 2

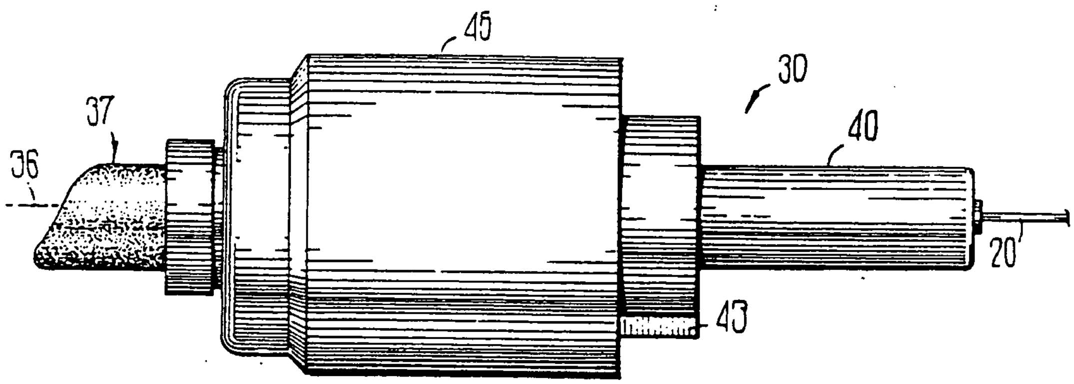

FIG 3

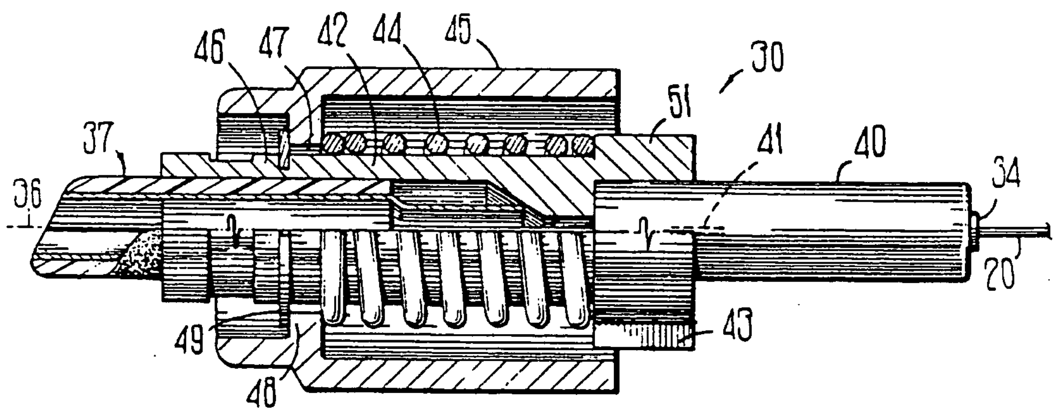

FIG 4

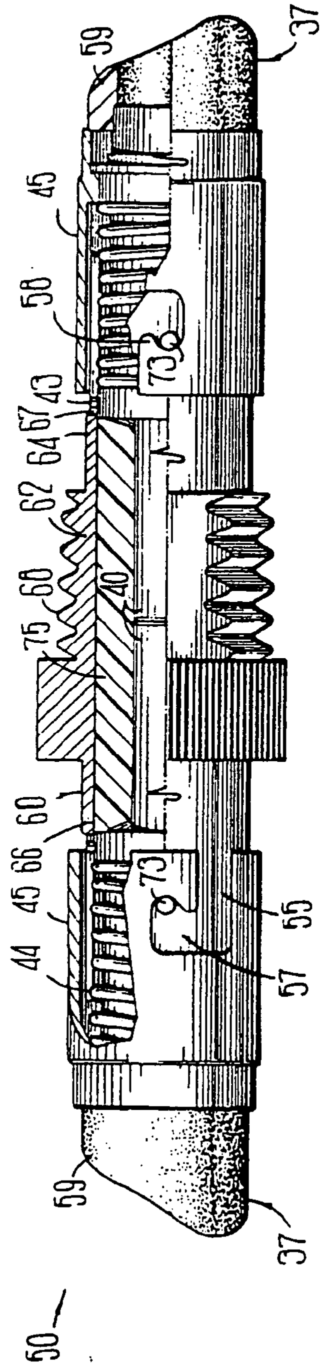

FIG 6

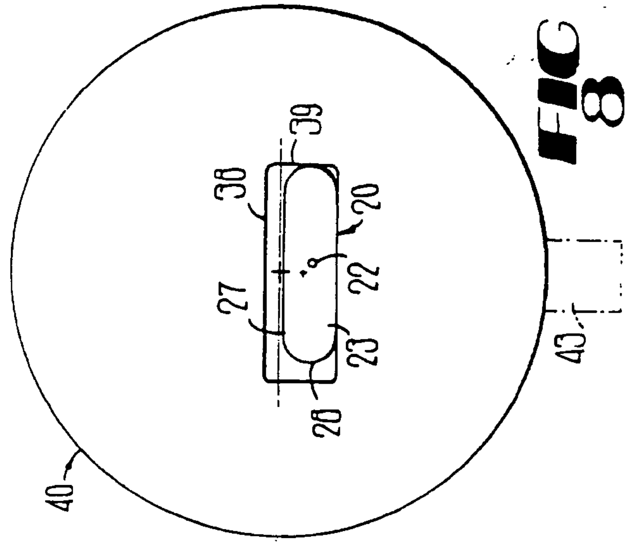

FIG 8

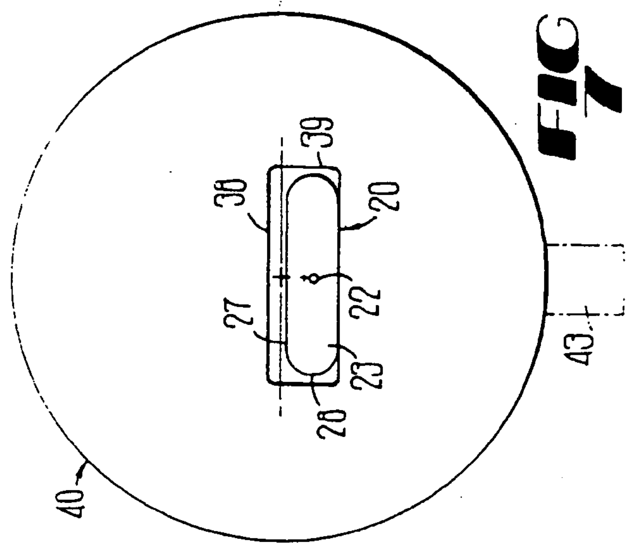

FIG 7

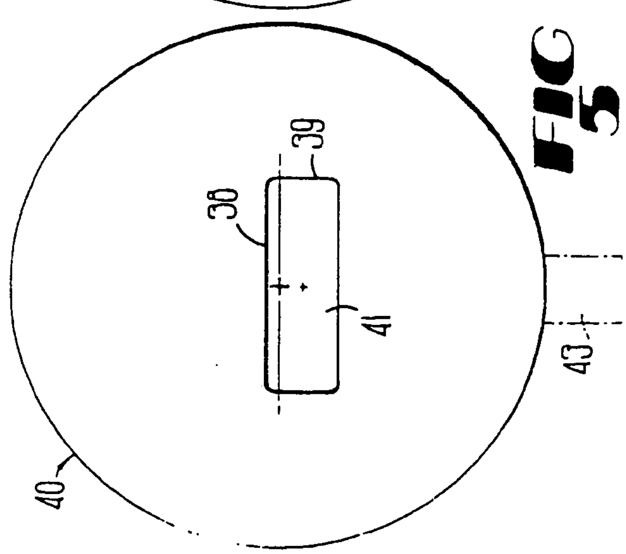

FIG 5

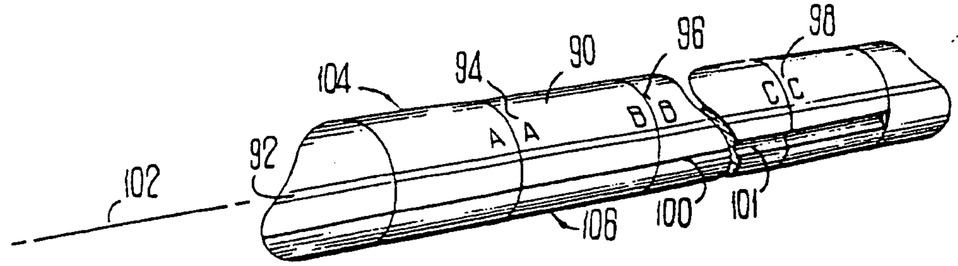

FIG 9

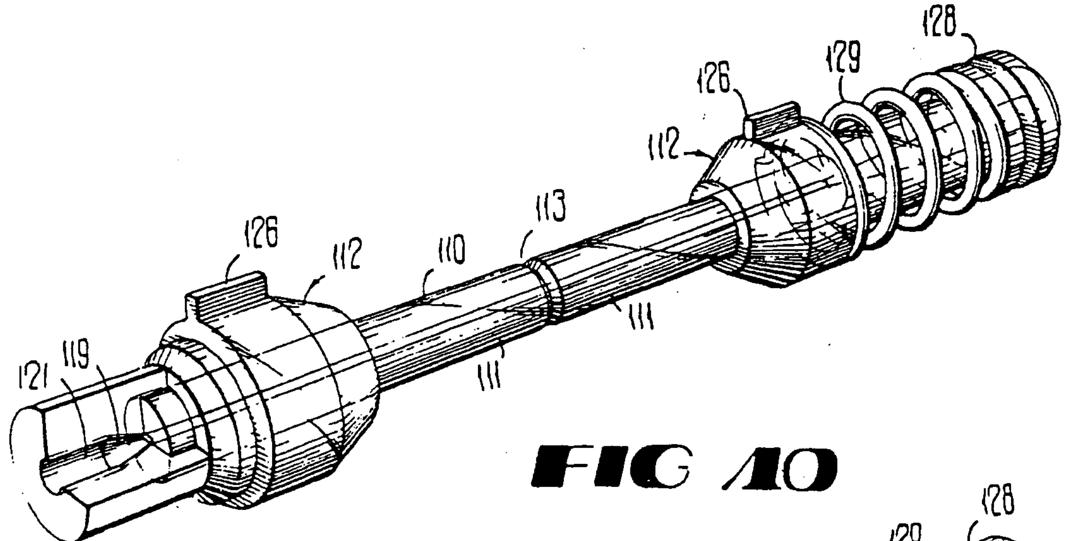

FIG 10

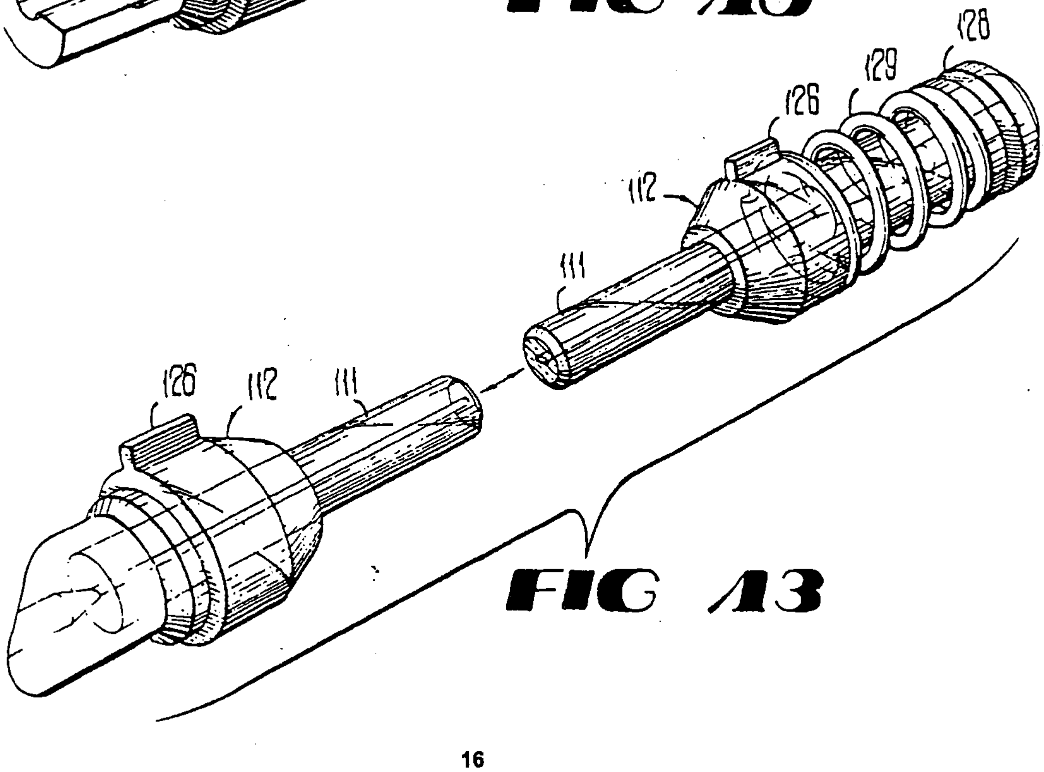

FIG 13

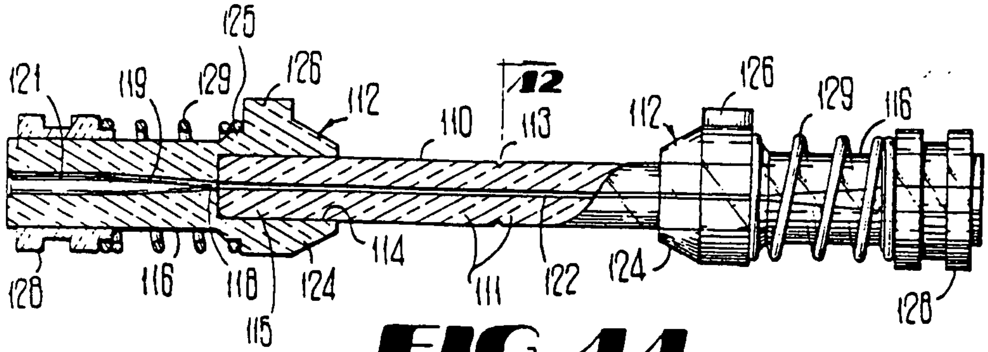

FIG 11

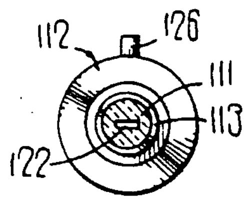

FIG 12

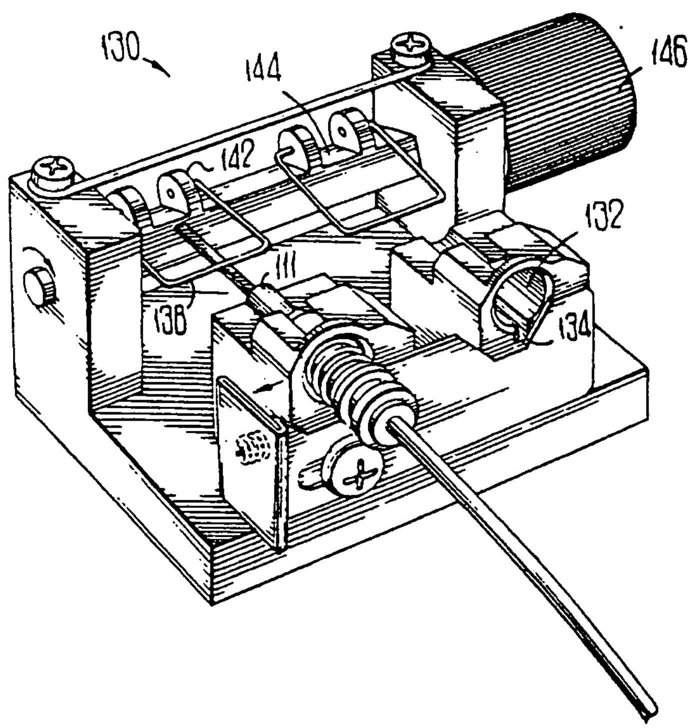

FIG 14

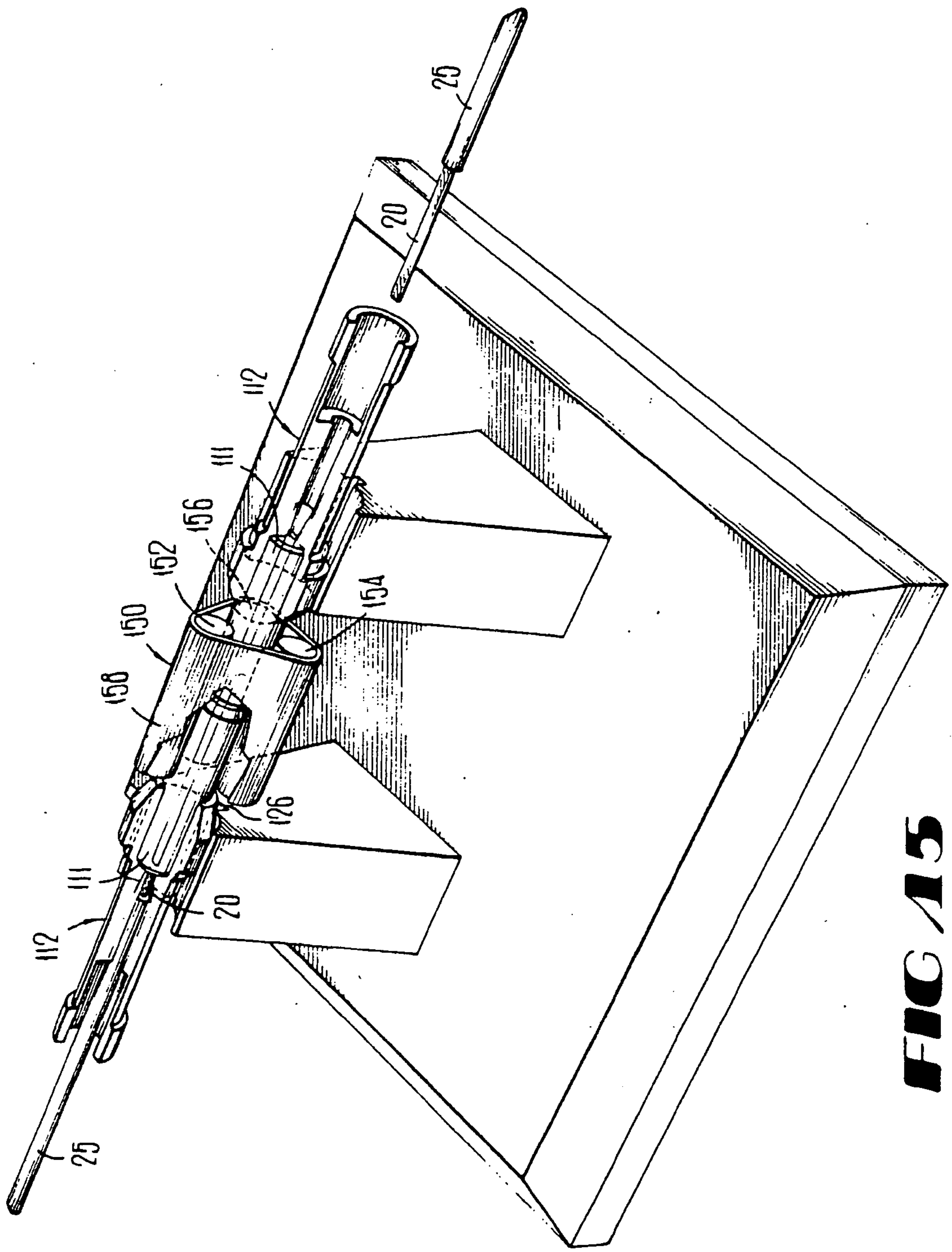

FIG 15